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Poor Sleep Quality Related to Impaired Cognitive Function Following Stroke: A Comparative Cross-Sectional Study

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A B S T R A C T

Sleep deprivation is a common concern among stroke patients. There was a connection between sleep deprivation and poor cognitive function. Few studies, however, have compared sleep and cognitive variations in older adults with and without stroke, as well as explored the relationship between sleep quality and cognitive function. The objective of this study was to explore the quality and feature of sleep between patients with and without a stroke. To assess the association between sleep quality and cognitive dysfunction in older adults. A cross-sectional analysis was carried out. 156 participants completed this research. The study was carried out in 90 stroke patients and 66 of non-stroke patients. The patient was given a sleep quality questionnaire and took a cognitive test. In addition, a multivariate linear regression statistical analysis was used to determine the relationship between two variables. The global mean PSQI in patients with stroke was 7.12±3.96 versus 4.98±2.86, respectively, higher than the non-stroke group. Around 56.7 percent of stroke patients complained of poor sleep quality. Stroke patients scored lower than those who did not get a stroke on the memory and executive function test. Sleep quality affects memory by 28.6 percent. Poor sleep quality was strongly associated with memory dysfunction in stroke patients. To prevent patients with stroke from experiencing cognitive loss, health care providers should develop effective interventions to improve sleep quality.

Kata kunci:

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A B S T R A K

Kurang tidur adalah masalah umum di antara pasien stroke. Ada hubungan antara kurang tidur dan fungsi kognitif yang buruk. Beberapa penelitian, bagaimanapun, telah membandingkan variasi tidur dan kognitif pada orang dewasa yang lebih tua dengan dan tanpa stroke, serta mengeksplorasi hubungan antara kualitas tidur dan fungsi kognitif. Tujuan dari penelitian ini adalah untuk mengeksplorasi kualitas dan fitur tidur antara pasien dengan dan tanpa stroke. Untuk menilai hubungan antara kualitas tidur dan disfungsi kognitif pada orang dewasa yang lebih tua. Sebuah analisis cross-sectional dilakukan. 156 peserta menyelesaikan penelitian ini. Penelitian dilakukan pada 90 pasien stroke dan 66 pasien non stroke. Pasien diberi kuesioner kualitas tidur dan menjalani tes kognitif. Selain itu, analisis statistik regresi linier multivariat digunakan untuk mengetahui hubungan antara dua variabel. Rata-rata PSQI global pada pasien stroke masing-masing adalah 7,12±3,96 versus 4,98±2,86, lebih tinggi daripada kelompok non-stroke. Sekitar 56,7 persen pasien stroke mengeluhkan kualitas tidur yang buruk. Pasien stroke mendapat skor lebih rendah daripada mereka yang tidak terkena stroke pada tes memori dan fungsi eksekutif. Kualitas tidur mempengaruhi memori sebesar 28,6 persen. Kualitas tidur yang buruk sangat terkait dengan disfungsi memori pada pasien stroke. Untuk

mencegah pasien stroke mengalami kehilangan kognitif, penyedia layanan kesehatan harus mengembangkan intervensi yang efektif untuk meningkatkan kualitas tidur.

INTRODUCTION

Stroke is the second most common cause of death across the world and the third leading cause of disability across the world (Johnson et al., 2019; Sonmez & Karasel, 2019). The incidence rate is declining in developed countries, while the incidence of stroke has increased in low-and middle-income countries over the last two decades (Johnson et al., 2019). It was reported that 2·7 million people die from ischemic stroke and that 2·8 million die from hemorrhagic stroke. Indonesia has seen an increase in stroke sufferers from 7% to 10.9% in the last five years (Riskesdas-kementrian kesehatan, 2018). A major stroke increases the risk of early death by two-fold, and those with physical and cognitive impairments after a stroke have even greater risk of a second stroke (Falck et al., 2019). As a result, recognizing factors that have a negative impact on the functional state of stroke patients is critical. Rehabilitation programs for strokes are therefore aimed mainly at improving and integrating functional and cognitive status required to conduct daily activities.

Sleep problems are a common concern among stroke patients, and they may also be a significant predictor of post-stroke health risk (Falck et al., 2019). Adults who have had a stroke are more likely to have one of the following sleep disorders – insomnia, OSA, and a sleep-wake cycle disorder (National Stroke Association, n.d.). Studies have found that insufficient sleep negatively impacts a person's health behaviors and outcomes. Poor sleep quality, for example, is associated with poor functional status, and that poor functional status could impact the outcomes of rehabilitation and lead to a poorer quality of life for individuals in the recovery process for stroke (Sonmez & Karasel, 2019). In stroke patients, reduced sleep quality is often linked to a lower quality of life (Kim & Moon, 2019). Moreover, stroke survivors are at an increased risk of mortality and have a poorer quality of life when compared to those without sleep issues (Samson & Nunn, 2015). Sleep can maintain healthy physical status in adults who have had a stroke. Although many of the causes of sleep problems remain unrecognized, it can create heavy burdens to people and society (Brewster et al., 2015).

Sleep is a mechanism and a brain condition that can also be interpreted as an action. It is an emergent of brain properties such as energy regeneration, brain metabolic, neural ontogenesis, and cognition (Samson & Nunn, 2015). The cognitive function refers to learning, retraining and recall; it also reflects a complexity of certain mental functions such as judgment and assessment (Zilberman et al., 2015). Many studies have shown that sleep deprivation and the lack of sleep in a number of problem areas including the prefrontal cortex can lead to diminished performance when faced with a task (Siccoli et al., 2008). Furthermore, obstructive Sleep apnea was showcased, causing difficulties to rehabilitate the stroke patients and degrading attention, executive functioning, visuoperception, ability to psychomotorise and understanding (Aaronson et al., 2015). A ccording to (Falck et al., 2019), stroke patients have lower sleep quality than their non-stroke peers, and those with low sleep quality have greater cognitive function deficits. As a result, enhancing sleep quality can be crucial to maintaining cognitive health.

There is much research showing how sleep has a clear effect on cognitive processes. Few studies have explored the differences in sleep quality in stroke patients compared to age-matched peers. There are few studies that have looked at the differences between stroke patients and non-stroke patients in regards to sleep and cognitive function (Falck et al., 2019). It's critical to comprehend how stroke occurrence is linked to sleep quality–and how sleep quality is linked to cognitive performance in older adults who have had a stroke versus adults who haven't had a stroke. Studying the relationship between good sleep and stroke will help determine whether good sleep can maintain stroke patients' physical and cognitive health. Thus, in this study, in order to look at how sleep quality relates to cognitive function, which is the most important part of the overall health of the patient. The objective of this study was to explore the quality and feature of sleep between patients with and without a stroke. To assess the association between sleep quality and cognitive dysfunction in older adults.

MATERIALS AND METHODS

Study design

This study was conducted using a cross sectional design with convenience sampling to adult with stroke and non-stroke group (healthy people). Patients with stroke were recruited from outpatient's clinic in one of referral hospital in Jakarta, while patients without stroke were recruited from one public health center in Jakarta, Indonesia. Data were collected from November 2020 to February 2021.

Sample

Sample in this study was patients with and without stroke. Eligible criteria for patients with stroke were aged over 40 years old, diagnosed as stroke confirmed from medical records for at least 6 months able to read and write Bahasa. Non-stroke group were recruited who met similar inclusion criteria but not diagnosed with stroke or hypertension of other comorbidity that confirmed with their health history. Psychiatric disorder had history of drug abuse, or impaired hearing or visual were excluded from this study.

Measurement

Sleep quality

The Pittsburgh Sleep Quality Index, a commonly used questionnaire, was used to measure sleep quality (PSQI). The PSQI is made up of seven sleep components, which are sleep quality, sleep latency, sleep time, sleep efficiency, sleep disturbance, sleep medicines and daily dysfunctional treatments. The PSQI scales from 0 (not at all) to 3 (three or

more times a week) and provide a total PSQI score ranging from 0 to 21. A person will be considered to have good sleep if his or her score is 5 or less and a person will be considered to have poor sleep if his or her score is 6 or more. Psychometric properties are good reliability (intra-class correlation 0.89, coefficient alpha 0.89) and good construct validity for the English language version of the test. In the present study, Cronbach's alpha was 0.76.

Cognitive test

The Montreal Cognitive Evaluation (MoCA) is a short cognitive monitoring tool that has shown high sensitivity and specificity in cognitive failure assessment (Nasreddine et al., 2005). The MoCA measures overall mental functioning including memory, attention, executive functioning, naming, verbal registration, and learning. Test scores range from 0 to 30, higher scores indicate better cognitive functioning. Cronbach's reliability for the original version was 0.86.

The Hopkins Verbal Learning Test (HVLT) is a test for evaluating learning and memory. The examination consists of a list of 12 nouns that are divided into three semantic groups. The test taker orally reads the list of 12 words to the participant. The participant then tries to remember as many words from this list as possible. Two more times the list is read verbally and the participant is reminded of as many words as possible each time. Score represents a sum of the correct responses for each of 3 study studies (perhaps 0 - 36 for summed reminder studies) and a late reminder test (possible score 0 to 12). The HVLT test specificities were 0.83 (Shapiro et al., 1999).

Trial Making Test (TMT) TMT is a test used for measuring executive functions, consisting of TMT A and B. TMT Making Test is a test. TMT A requires a person to draw lines that link 25 enclosed numbers distributed on a paper sheet sequentially. Task requirements for TMT B are similar except for numbers and characters (e.g., 1, A, 2, B, 3, C). The maximum time to answer each multiple-choice question is 150 seconds. Each part requires a certain amount of time to be completed. A higher score shows a worse performance (Chen RH, Chen, 2002).

Procedure

Approvals were obtained from the Institutional Review Board at the site hospital. Participants were recruited while visiting the clinic. All participants gave consent to participate. The principal investigator and research assistants in training conducted the interview which took place in a private room at the hospital's outpatient clinic. Patients were asked to rate their sleep quality patterns and then they were tested on their cognitive capabilities. This test took about 60 to 90 minutes.

Statistical Analysis

The Statistical Package for Social Sciences (SPSS) 20.0 was used to conduct the statistical analysis (SPSS Incl., Chicago, IL). Independent t tests were used to compare demographic, clinical information, sleep characteristics, and cognitive function between patients with and without stroke. To see if there was a connection between sleep characteristics and cognitive tests, researchers used person correlation. After adjusting for age and education, a liner regression model was used to assess the relationship between sleep quality and cognitive test.

RESULTS

Participant characteristics

As shown in Table 1, 156 people participated in this survey, 90 of whom had a stroke and 66 of whom did not. Patients with stroke did not differ significantly in age (mean=63.12±7.46 vs. 62.77±7.24, respectively), and 48.7% of each sample was female. Stroke patients had lower education level and were more obese than the non-stroke group. The average length of a stroke was 5.75 years (SD=1.81).

Table 1.
Comparison of demographic and clinical information among patients with stroke and non-stroke (N=156)

	Stroke (n= 90)	Non-Stroke (n= 66)	*p*-value
Age, mean (SD)	63.12 (7.46)	62.77 (7.24)	0.101
Female, n (%)	47.3%	49.8%	0.357
Marital status, n (%)			
Married	62 (68.9)	45 (68.2)	0.213
Single/Divorce/Separate	28 (32.1)	21 (32.2)	
Education level, n (%)			
Below junior high school	52 (57.8)	25 (37.9)	0.019
Above junior high school	29 (42.2)	44 (62.1)	
No smoking, n (%)	88 (97.8)	65 (92.4)	0.615
Body Mass Index	25.4 (4.72)	23.3 (3.87)	0.003
Duration of stroke (year)	5.75 (1.81)	-	-

Sleep characteristics

Table 2 summarizes the differences in sleep characteristics between stroke patients and non-stroke patients. Patients with stroke had a higher mean global PSQI score than those without a stroke, 7.123.96 vs. 4.982.86, respectively. Around 56.7 percent of stroke patients complained of poor sleep quality. In addition, patients with stroke were found to report significantly lower sleep quality than their healthy counterparts (0.87±1.26 vs. 0.27±0.73, p=0.001). It is shown that patients with stroke had longer sleep latency (1.49±1.07 vs. 1.42±1.02) and shorter sleep duration (1.61±1.22 vs. 1.5±1.19) both compared to non-stroke group in PSQI. On the other hand, the use of sleeping pills had a slightly lower mean score (0.23±0.6 vs. 0.20±0.56).

Table 2.
Comparison of sleep characteristics patients with stroke and non-stroke (N=156)

	Stroke Mean ±SD	Non-Stroke Mean ±SD	*p*-value
Sleep quality			
The global PSQI score	7.12±3.96	4.98±2.86	0.031
Subjective sleep quality	0.87±1.26	0.27±0.73	0.001
Sleep latency	1.49±1.07	1.42±1.02	0.705
Habitual sleep efficiency	0.55±0.97	0.42±0.87	0.387
Sleep disturbances	1.24±0.55	1.18±0.42	0.440
Use of sleep medication	0.21±0.52	0.17±0.42	0.572
Daytime dysfunction	1.14±0.74	1.11±0.61	0.745
Sleep duration	1.61±1.22	1.5±1.19	0.572
Cognitive function			
Global Cognitive Function	25.2±3.07	26.2±2.83	0.134
Memory			
HVLT, total	20.6±5.03	23.0±5.64	0.039
HVLT, delay	7.3±2.80	8.6±3.39	0.053
Executive Function			
TMT A	70.4±45.19	49.6±23.4	0.018
TMT B	130.4±88.9	83.7±49.09	0.008

Note: MoCA: Montreal Cognitive Assessment; HVLT: Hopkins Verbal Learning Test; TMT: Trial Making Test

Cognitive function characteristics

Table 2 compares the cognitive output of stroke patients and non-stroke patients. Stroke patients had lower than non-stroke patients in terms of memory (HVLT, 7.3±2.8 vs. 8.6±3.39) and executive function (Trial Making A, 70.4±45.19 vs. 49.6±23.4 and Trial Making B, 130.4±88.9 vs. 83.7±49.09) In addition, stroke patients reported lower scores on delayed memory recall and global cognitive function but did not reach significance (p value > 0.005).

Correlation between sleep characteristic and cognitive function

Table 3 depicts the relationship between sleep characteristics and cognitive function in stroke patients. Daytime dysfunction also shows to be a strong negative association with the majority of cognitive domains, including but not limited to global cognitive function (r=-0.213), memory (HVLT, r=-0.239), and executive function (TMT A, r=0.266 & TMT B, r=0.298). Poor sleep efficiency was negatively associated with executive function (TMT A, r=0.273). Sleep duration was associated with global cognitive function (r=-0.287). There was a significant correlation between habitual sleep efficiency and global cognitive function (r=-0.227) and executive function (r=0.273). Furthermore, there was no statistically significant connection between subjective sleep quality and cognitive function. The multivariate regression analysis indicated that age and sleep quality explained 28.6% of the variance in memory performance (Table 4).

Table 3.
Correlation between sleep characteristic and cognitive test in patients with stroke (n=90)

	MoCA	HVLT	TMT A	TMT B
Subjective sleep quality	0.024	0.174	-0.060	0.017
Sleep latency	-0.075	-0.089	0.220*	0.135
Sleep duration	-0.220*	-0.165	0.131	0.114
Habitual sleep efficiency	-0.227*	-0.150	0.273*	0.024
Sleep disturbances	0.043	-0.067	0.095	0.067
Use of sleep medication	-0.204	-0.250*	-0.040	0.218*
Daytime dysfunction	-0.213*	-0.239*	0.266*	0.298**

Note: MoCA: Montreal Cognitive Assessment; HVLT: Hopkins Verbal Learning Test; TMT: Trial Making Test; *Correlation is significant at the 0.01 level (2-tailed); **Correlation is significant at the 0.05 level (2-tailed).

Table 4.
Multiple Regression Analysis Explanatory Variable for Cognitive Function in Patients with Stroke (n=90)

Variables	Mo CA B (SE B)	HVLT B (SE B)	TMT A B (SE B)	TMT B B (SE B)
Age	-0.09 (0.05) *	-0.22 (0.08) **	1.1 (0.53) *	2.2 (1.28)
Educational Level	0.55 (0.28)	0.74 (0.49)	-12.1 (2.39) **	-16.1 (8.13)
BMI	0.008 (0.07)	-0.16 (0.12)	1.5 (0.74)	5.2 (2.68)
R^2	0.205	0.231	0.371	0.204
Sleep quality score	-0.11 (0.08)	-0.34 (0.14) *	0.27 (0.91)	2.2 (2.16)
R^2	0.223	0.286	0.371	0.204
$\triangle R^2$	0.018	0.054	0.001	0.010

*p <0.05; **p <0.01; *** p < 0.001

DISCUSSION

To the best of our knowledge, this is the first study to examine the relationship between sleep quality and cognitive function in stroke patients from Indonesia. Patients who had a stroke had poor sleep quality compared to patients without stroke. Even after controlling for demographic and clinical variables, sleep quality significantly predicts memory.

In this study, stroke patients spend longer and more fragmented periods of sleep than non-stroke patients. The current findings relate to the fact that the majority of hospitalized stroke patients have sleep disorders (Falck et al., 2019). The study found that sleep disorders and stress increase the risk of having a stroke and vice versa (Hepburn et al., 2018). One possible explanation for the different sleep problems that people have after a stroke is that stroke causes damage to different areas of the brain, specifically the parts that control different aspects of sleep architecture and sleep quality like the brainstem, hypothalamus, preoptic area, and the thalamus (Ferre et al., 2013). Unfortunately, poor sleep is likely multifactorial in origin. Symptoms may include sleep apnea and sleep-wake cycle disorders. Changes in the brain's oscillations can affect sleep. Psychological changes, such as depression and fatigue, may play a role (Oh & Seo, 2015). Taken together, patients with stroke may not be identified as such until sleep quality has been poor for a long time and if taken care of, the condition may be treated. More studies are needed to determine factors associated with the quality of sleep in patients with stroke.

Patients with strokes were more likely to complain of short sleep duration. This result contrasts with a previous study by (Falck et al., 2019), which found that older adults with stroke sleep for longer periods of time than older adults without stroke. Researchers found that adults with stroke have short sleep duration compared to healthy adults. clinical effects of stroke depend on both the age at which the stroke occurs and the length since the stroke (i.e., acute vs. chronic stroke). Therefore, it is very important to develop strategies that maintains patients awake for a longer period of time to prevent any stroke complications further down the line.

Patients who had a stroke had less memory and executive performance than those who had not had a stroke. Previous studies show that stroke survivors suffer from higher rates of mild cognitive impairment, and the odds of having severe cognitive impairment are higher among stroke survivors compared to non-stroke persons (Delavaran et al., 2017). Strokes can cause major damage to the central nervous system, reducing one's ability to process information, which, in turn, can make older adults much less capable of performing complex functions. It has been observed that in many cases of dementia are caused by cerebrovascular disease (stroke, silent infarction, small vessel disease, microinfarction, and cerebral amyloid angiopathy) (Delavaran et al., 2017). Furthermore, antidementia treatments as well as some nonpharmaceutical therapies, such as diet, cognitive therapy, and physical activity, can help people with stroke-related cognitive impairment. Longitudinal research of whether poor sleep affects cognition in stroke survivors is necessary.

Poor sleep efficiency was associated with lower scores in all cognitive tests. Studies have found that poor sleep efficiency is associated with a decline in global cognitive function (Elcombe et al., 2015). Basically, more sleep is associated with improved cognitive performance–both immediately following a stroke and 3 months after stroke recovery (Hermann & Bassetti, 2009). Although there is no conclusive evidence that sleep quality is a factor in recovery from stroke, there is an evidence that poor sleep quality hinders recovery (Siccoli et al., 2008). Our cross-sectional design study found that the decrease in sleep efficiency affected more cognitive domains. A analysis of 41 studies showed that objective sleep performance assessment was linked to more cognitive domains, including executive control, concentration, working memory, and processing speed (Brewster et al., 2015). To our knowledge, our findings in stroke patients in Indonesia are novel and were previously not demonstrated. Future studies may use objective measurements to explore sleep architecture in relation to cognitive function. It is also important to ensure that treatment interventions to improve sleep efficiency are implemented for all stroke patients.

After adjusting for age and education, sleep quality is a predictor of memory. To date, the underlying mechanism that causes poor sleep quality to cause cognitive loss is unclear. (Zhang et al., 2017) found a connection between impaired prospective memory and sleep breathing problems, which included both blood oxygen levels and air flow through the respiratory tracts. A study in a healthy population showed that poor sleep quality is detrimental to the consolidation of new information and reduced the number of durable memories (Cipolli et al., 2013). So far, studies have only explored the causal relationship between poor sleep quality and having impaired memory in stroke patients. Given the importance of sleep for cognition, interventions aimed at improving sleep quality in these individuals are needed.

CONCLUSIONS

In conclusion, patients with stroke had poor sleep quality compared to non-stroke group and shorter sleep duration was the most common complaint among patients with stroke. In addition, patients with stroke had worse of memory and executive function than non-stroke patients. Poor sleep efficiency was associated with worse of global cognitive function, memory, and executive function. Then, Sleep quality is predictor of memory after controlling age and education. Future longitudinal studies using objective sleep architecture measurement are required to investigate the relationship between sleep and cognitive function in stroke patients. In addition, more research is needed to determine how poor sleep quality affects cognitive function. Health care providers must develop effective interventions to improve sleep quality to prevent stroke-related cognitive decline.

Conflict of interest

All authors declare no conflict of interest

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